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Paper Session II-C - Teamworking Skills- A Spinoff of High School Space Experiments

Laura Reeves

Space Resource Teacher, Office of Applications for Technology, Phillips Laboratory, Kirtland Air Force Base

TEAMWORKING SKILLS — A SPINOFF OF HIGH SCHOOL SPACE EXPERIMENTS

Laura Reeves
SPACE Resource Teacher, Office of Applications for Technology
Phillips Laboratory, Kirtland Air Force Base
Albuquerque, New Mexico

ABSTRACT

The design of many high school classes encourages students to work independently rather than with others—yet in the working world, it is often necessary for employees to work in cooperative groups. In Phillips Laboratory's *High School SPACE Experiment Program,* teamwork is taught as an essential part of the experimental process. The program directs students to plan, structure, and perform year-long space science experiments. While participation in the *SPACE Experiment Program is* voluntary, the "space" theme motivates students to join. Each team is guided by two Phillips Laboratory mentors—scientists willing to share their knowledge and experience with the high-schoolers. With the direction of the mentors, students learn to work together and organize their tasks to accomplish their objectives in a timely fashion. By the end of the year, the mentors' roles have shifted from leaders to observers as the students take ownership of their experiment and become a synergetic team.

OVERVIEW OF THE SPACE EXPERIMENT PROGRAM

Now in its fourth year, the *Phillips Laboratory High School SPACE Experiment Program* strives to combine the technical expertise of Laboratory mentors, the educational experience of science teachers, and the enthusiasm of high school students. In addition to providing a valuable community service, a major goal of the program is to provide a team learning experience otherwise unattainable to the students.

With the aid of their teachers and Phillips Laboratory mentors, students structure and perform high quality year-long experiments. The program is entirely voluntary-the mentors, teachers and students give their own time to perform the experiment, usually meeting after school and on weekends.

Ten teams took part in the SPACE Program this year—the participants totaled 190 students, 12 teachers and 30 mentors. Phillips Laboratory provided up to $1000 in materials per team in addition to the loan of specialized equipment from the mentors' laboratories.. At the end of the program, each team wrote a final report and gave a final presentation to the other teams, principals, and Phillips Laboratory personnel.

CALENDAR SUMMARY

August-September:	Mentors recruited from Phillips Laboratory.
September:	Teachers invited to join the program. Mentors trained and assigned to a school team. (Each team generally has two to three mentors.)
October:	Teams meet for the first time. Team leaders selected, meeting times discussed, and experiment topic chosen.
November:	Experiment topic thoroughly researched. Students tour Phillips Laboratory.
December:	Materials ordered through Phillips Laboratory.
January	Interim report written.
January-March;	Experiment performed. Data collected.
February	Quad chart summary submitted.
March:	Experimental results analyzed.
April	Final report written. Final oral presentations and demonstrations held at Phillips Laboratory.
May:	Mentors and teachers submit evaluations of the program.

TEAMWORK

Because the majority of high school classes are structured to encourage independent work rather than team work, the *High School SPACE Experiment Program* was designed to fill this gap by requiring intensive cooperation. Also, because the experiments are year-long, a continuity exists that is normally absent in the typical classroom.

As the program progresses, the process of team building gradually takes place. At the beginning of the program, students are inexperienced in leadership skills, so the Phillips Laboratory mentors must act as the group leaders. Organizational and team skills are taught before much time is spent discussing the project topic. Students are directed to select their own leader. When the experiment topic is chosen, students subdivide themselves into specialized groups, each handling one area of the experiment. A time line is established and later modified.

The shift in leadership from mentor-as-leader to mentor-as-observer is a fascinating process. The change seems to occur rather suddenly at some critical point in the experiment. Every team is different, but this transfer of leadership usually happens unconsciously after the students have accomplished a major milestone in the experiment. At that point, students begin to experience a true ownership of the project.

A LOOK AT ONE EXPERIMENT: "MARS CAR" by THE CAREER ENRICHMENT CENTER[1]

The Albuquerque Public Schools Career Enrichment Center (CEC) is an alternative school serving students from the area high schools. Students enroll in specialized classes that would not ordinarily have sufficient enrollment in a single high school.

The chief goal of the Mobile Automated Remote System (MARS) Car project was to fabricate an automated and partially remote user-operated multi-terrain vehicle. The students designed and constructed this vehicle as if it were to be stationed on and operated in the harsh conditions on the surface of the planet Mars.

The vehicle was equipped with a multitude of sensors, including microwave, bump switches, incline, and live video transmissions. The "brain" of the car was a robot, which interfaced to each of the systems. A robotic arm, controlled via radio control, was used to collect and interact with samples on the surface. The operator controlled the vehicle by means of radio control, obtaining input from a television monitor that received live video transmissions from a miniature on-board camera. While receiving input from all of the on-board sensors, the vehicle was capable of controlling its own course while avoiding collisions and obstacles.

Theoretically, the vehicle was to be able to withstand the conditions on Mars, including temperature, rough terrain, atmospheric conditions, and high wind speeds. Although some of the modifications necessary to withstand certain conditions (extremely low temperatures, certain atmospheric conditions, etc.) were unattainable, the team was able to attain others, such as high winds and rough terrain (to an extent).

The teams subdivided themselves into several smaller groups. This allowed each group to specialize in their fields and focus upon a specific system. The titles of the groups were: *power*, *sensors*, *systems* and *management*.

The *power* group ensured that each vehicle system received the power it required, while still conserving electricity. The team consisted of two students who were to find a power source that was reliable and would supply the required amount of power at all times. The pair made several inquiries to wheelchair distributors in order to find if a wheelchair engine would be right for the MARS Car. They also did library searches on power sources. After extensive research, the power group decided to use a DC battery that would be recharged via solar energy.

The *sensor* group, a three-person team, contrived and abandoned many ideas for possible sensors before deciding on the final selection: a microwave sensor, mounted on the front of the vehicle to detect motion and range; a bump sensor consisting of a ring, attached to a

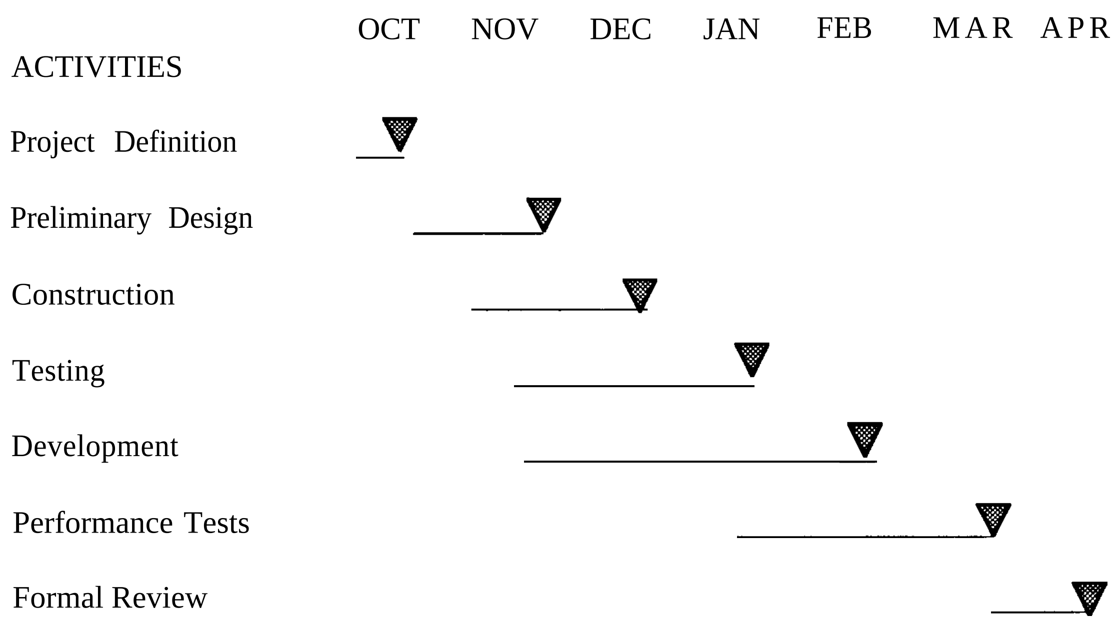
[1] Mobile Automated Remote System (MARS Car), Career Enrichment Center SPACE Experiment, Teacher: Maria Gnego; Phillips Laboratory Mentors: Jon Shively, Michelle Kazmier Students: Randy Bigbie, Gabriel Garcia, Mike Kizer, Anthony Pircher, Nick Majeran, Jason Parker, Paul Starr, Ryan Vines, Keith Kraft, Aspen Montoya, James Akita

microswitch that surrounded the car to detect collisions; and a small wireless TV camera mounted on the end of the robot arm for remote control.

The six-person ***systems*** group was in charge of coordinating all of the input and output from the various other systems, sensors, and robots. The team decided on the size and weight of the car, damage protection, proper motor configuration, and placement of the robot. The students developed a method to move the vehicle from point A to point B, collect and store samples, and use the sensors to guide the car and take measurements.

The *management* team was in charge of coordinating all of the groups, enforcing deadlines, and handling the day-to-day management of the experiment team. They developed the following timeline to keep everyone on track:

CEC MARS CAR
SCHEDULE



On April 22, 1995, the CEC team gave an oral presentation of their project at the SPACE Final Presentation meeting. The audience was made up of parents, principals, Phillips Laboratory personnel, government dignitaries, and the other student teams. Each of the four CEC subgroups took turns summarizing its part in the experiment using charts, graphics, and slides. The presentation was followed by a demonstration of the MARS Car. While being remotely controlled by the operator of its video camera, the car moved from the auditorium and out into the halls of the building, being eagerly followed by a group of impressed onlookers.

COMMENTS ON TEAMWORK

The following quotations indicate the struggles, frustrations, rewards, pride and accomplishments attained during the program.

"The students learned to appreciate the work, time, effort and teamwork required in a research effort."
— Teacher, Eldorado High School.

"The power group has been given the cold shoulder by the majority of the team. We feel that power is the most important of the internal components of the MARS Car. We adamantly suggest that our group be given more attention in order to complete our task within the deadline."
— The Power Group, Career Enrichment Center (during the initial stages of the program).

"The kids basically did the design and execution themselves with guidance by mentors, as it should be!"
— Phillips Laboratory mentor for the Sandia High School team.

"During a recent meeting, the student teams went to a satellite dish vendor to look at the mounting brackets. The first vendor would not allow the group into his store, even after we explained the purpose of the visit, and our affiliation with Phillips Lab. He was quite rude. We then went to a second store, where the owner was quite helpful. He spent twenty minutes with us answering questions and making recommendations."
— Phillips Laboratory mentor for the La Cueva High School team.

"My students learned to handle teamwork, deadlines, money and spending accountability."
— Teacher, Cibola High School.

"We have learned that working on a project like this is not easy. At first, the group had problems working together and communicating. After the less dedicated members dropped out, it was much easier to work on the project and have productive meetings."
— Student, Cibola High School.

"The students learned about conducting science in a real-life situation. I believe this was a valuable experience."
— Teacher, Holy Ghost School.

"The students first organized themselves into fictional groups. The groups applied their expertise, as well as coordinated with each other to optimize on a final design." (A list of the groups followed. One of the groups was entitled "Dictator"!) "The 'Dictator' facilitated an orderly and productive meeting, ensuring no one talked too much and asking quiet members for their opinions. The team learned quickly about group dynamics and the potential problems when specific responsibilities were not delineated."
— Phillips Laboratory mentor for the Cibola High School team.

“The students had a wonderful time participating in this program! What a splendid opportunity for a group of students who miraculously attended all their classes (C-level special education, extensive services). For a few moments in the spotlight, they were on ‘equal turf’ with their peers. (And, I believe they gave the best presentation, too !—But I am only slightly biased!)”
—Teacher, Rio Grande High School.